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FRAGMENTATION OF ELEMENTARY EXCITATIONS IN THE TRANSITIONAL MOLYBDENUM ISOTOPES

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ABSTRACT

A two nucleon transfer study of the molybdenum isotopes has been carried out to investigate the transitional character of these nuclei. The results indicate the lighter nuclei have spherical shell model characteristics whereas the heavier nuclei are rapidly becoming deformed.

INTRODUCTION

The molybdenum isotopes represent an interesting situation with regard to the concept of elementary pairing excitations. They lie near the Zr isotopes which appear to be characterized by shell model considerations[1] up to A=98 with an excited deformed band[2] which becomes the ground state band above A=98. However, above Mo lie the Ru and Pd nuclei which are more spherical in nature with superconducting ground states, this being true up to A=110 for the Pd nuclei. It is, thus, of interest to examine specifically how the Mo isotopes behave as a function of neutron number and to see where the onset of deformation occurs and the rapidity at which it happens. The two nucleon transfer reaction is ideal for such a study as it is quite sensitive to a change in ground state configurations in the two nucleon transfer overlaps. A previous study had illustrated that ^{102}Mo does appear to be deformed[3], and several (p,t) studies also exist in this region[4,5].

EXPERIMENTAL TECHNIQUE

These experiments were performed with a 17 MeV triton beam from the LASL Van de Graaff accelerator. The reaction protons were detected in a Q3D spectrometer by a helical proportional chamber[6]. Relative cross sections were checked with a natural target. The significant L=0 transitions observed in this experiment for targets of ^{92,94,96,98,100}Mo are listed in Table 1.

Table 1 Distorted Wave (DW) corrected cross sections (ε-values)

A(Final) =	94	96	98	100	102
ε[E_x(MeV)]	1.17[0]	1.68[0]	1.65[0]	1.48[0]	1.28[0]
	0.07[1.742]	0.02[1.148]	0.02[0.735]	0.11[0.694]	0.60[0.696]
	0.05[3.267]		0.04[1.965]	0.08[2.033]	0.11[1.334]

DISCUSSION

The Zr isotopes between ^{90}Zr and ^{96}Zr have two nucleon transfer strengths to ground states which are dominated by the $(d_{5/2})_J$ configuration. This gives a theoretical ratio of transition strengths for 90→92:94→96 of 1.0:1.7 and the data give reasonable agreement with this[1]. The Mo results agree also with this trend for 92→94:94→96 where the ratio is 1.44. For the heavier isotopes, however, there seems to be considerable configuration mixing with the ratio of g.s. transition strengths remaining more constant, as expected in the superconducting nuclear case. Finally, in the case of ^{102}Mo, the g.s. strength drops. This trend is associated with a rapidly increasing strength to excited 0^+ states, most notably in ^{102}Mo where the strength of the transition to the 0.696-MeV state is approximately one-half of the g.s. strength and in ^{100}Mo where the 0.694-MeV state is populated with 20% of the g.s. strength. Thus, the structure of the Mo isotopes appears to change from simple shell model to large configuration mixing to deformation onset, all within the addition of 8 neutrons.

The overall elementary exictation strength remains approximately constant from mass 96 to 102 in spite of the fragmentation (see Table 1).

Recently, the shape transition that occurs in the heavy Mo isotopes has been considered as due to a strong isoscalar n-p interaction. This interaction, as suggested by Federman et al.,[7] is due to the filling of the $1g_{7/2}$ proton shell and the presence of protons in the partially filled $1g_{9/2}$ proton shell.

An understanding of the behavior of the heavier Mo isotopes may also be possible using the techniques of the Interacting Boson Model[8] as has been applied to the Sm shape transitional region.

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